CLAIMS

What is claimed is:

1. A system for a lithotripter, comprising:

a shockwave generator;

an ultrasonic transmitting/receiving unit comprising an ultrasonic transducer configured to emit ultrasonic pulses and receive ultrasonic waves reflected from a target area of the shockwave generator; and

an evaluating unit, in communication with the ultrasonic transmitting/receiving unit, configured to determine a correlation coefficient (K) of a time correlation between the ultrasonic waves and the ultrasonic pulses and to provide a signal related to the correlation coefficient (K).

2. The system of claim 1, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

3. The system of claim 1, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

4. The system of claim 1, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

5. The system of claim 1, wherein the ultrasonic transducer is a pin probe.

6. The system of claim 1, further comprising an X-ray locating device.

7. The system of claim 1, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, the minimum value of the correlation coefficient (K) is not less than a predetermined first threshold value.

8. The system of claim 7, wherein the evaluating unit is further configured to average the minimum value of the correlation coefficient (K) over a plurality of shockwaves.

9. The system of claim 7, wherein the evaluating unit is further configured to standardize the minimum value of the correlation coefficient (K) to a reference minimum value of a reference correlation coefficient curve.

10. The system of claim 7, further comprising means for the continuous representation of the minimum value of the correlation coefficient (K) over a treatment duration.

11. The system of claim 7, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

12. The system of claim 11, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

13. The system of claim 7, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

14. The system of claim 7, wherein the evaluating unit comprises adjusting means for adjusting the first threshold value.

15. The system of claim 7, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

16. The system of claim 7, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

17. The system of claim 7, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

18. The system of claim 7, wherein the ultrasonic transducer is a pin probe.

19. The system of claim 7, further comprising an X-ray locating device.

20. The system of claim 1, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, a relaxation time (T_R) of the correlation coefficient (K) is not less than a predetermined second threshold value.

21. The system of claim 20, wherein the evaluating unit is further configured to average the relaxation time (T_R) of the correlation coefficient (K) over a plurality of shockwaves.

22. The system of claim 20, wherein the evaluating unit is further configured to standardize the relaxation time (T_R) of the correlation coefficient (K) to a reference relaxation time of a reference correlation coefficient curve.

23. The system of claim 20, further comprising means for the continuous representation of the relaxation time (T_R) of the correlation coefficient (K) over a treatment duration.

24. The system of claim 20, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

25. The system of claim 24, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

26. The system of claim 20, wherein the evaluating unit is configured to determine the relaxation time (T_R) by adapting a fit curve or a curve of the form $1 - A^{(-t/T_R)}$ to the variation of the correlation coefficient (K) with time.

27. The system of claim 26, wherein the evaluating unit is further configured to smooth the variation of the correlation coefficient (K).

28. The system of claim 20, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

29. The system of claim 20, wherein the evaluating unit comprises adjusting means for adjusting the second threshold value.

30. The system of claim 20, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

31. The system of claim 20, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

32. The system of claim 20, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

33. The system of claim 20, wherein the ultrasonic transducer is a pin probe.

34. The system of claim 20, further comprising an X-ray locating device.

35. The system of claim 1, further comprising a display device in communication with the evaluating unit and configured to display the variation of the correlation coefficient (K) with time.

36. The system of claim 35, wherein the evaluating unit is further configured to smooth the variation of the correlation coefficient (K).

37. The system of claim 35, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, the minimum value of the correlation coefficient (K) is not less than a predetermined first threshold value.

38. The system of claim 37, wherein the evaluating unit is further configured to average the minimum value over a plurality of shockwaves.

39. The system of claim 37, wherein the evaluating unit is further configured to standardize the minimum value of the correlation coefficient (K) to a reference minimum value of a reference correlation coefficient curve.

40. The system of claim 37, further comprising means for the continuous representation of the minimum value of the correlation coefficient (K) over a treatment duration.

41. The system of claim 37, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

42. The system of claim 41, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

43. The system of claim 37, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

44. The system of claim 37, wherein the evaluating unit comprises adjusting means for adjusting the first threshold value.

45. The system of claim 37, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

46. The system of claim 37, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

47. The system of claim 37, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

48. The system of claim 37, wherein the ultrasonic transducer is a pin probe.

49. The system of claim 37, further comprising an X-ray locating device.

50. The system of claim 35, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, a relaxation time (T_R) of the correlation coefficient (K) is not less than a predetermined second threshold value.

51. The system of claim 50, wherein the evaluating unit is further configured to average the relaxation time (T_R) of the correlation coefficient (K) over a plurality of shockwaves.

52. The system of claim 50, wherein the evaluating unit is further configured to standardize the relaxation time (T_R) of the correlation coefficient (K) to a reference relaxation time of a reference correlation coefficient curve.

53. The system of claim 50, further comprising means for the continuous representation of the relaxation time (T_R) of the correlation coefficient (K) over a treatment duration.

54. The system of claim 50, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

55. The system of claim 54, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

56. The system of claim 50, wherein the evaluating unit is configured to determine the relaxation time (T_R) by adapting a fit curve or a curve of the form $1 - A^{(-t/T_R)}$ to the variation of the correlation coefficient (K) with time.

57. The system of claim 56, wherein the evaluating unit is further configured to smooth the variation of the correlation coefficient (K).

58. The system of claim 50, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

59. The system of claim 50, wherein the evaluating unit comprises adjusting means for adjusting the second threshold value.

60. The system of claim 50, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

61. The system of claim 50, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

62. The system of claim 50, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

63. The system of claim 50, wherein the ultrasonic transducer is a pin probe.

64. The system of claim 50, further comprising an X-ray locating device.

65. The system of claim 1, wherein the evaluating unit is configured to determine the correlation coefficient (K) based on the ultrasonic waves assigned to the ultrasonic pulses directly succeeding one another.

66. The system of claim 65, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, the minimum value of the correlation coefficient (K) is not less than a predetermined first threshold value.

67. The system of claim 66, wherein the evaluating unit is further configured to average the minimum value of the correlation coefficient (K) over a plurality of shockwaves.

68. The system of claim 66, wherein the evaluating unit is further configured to standardize the minimum value of the correlation coefficient (K) to a reference minimum value of a reference correlation coefficient curve.

69. The system of claim 66, further comprising means for the continuous representation of the minimum value of the correlation coefficient (K) over a treatment duration.

70. The system of claim 66, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

71. The system of claim 70, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

72. The system of claim 66, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

73. The system of claim 66, wherein the evaluating unit comprises adjusting means for adjusting the first threshold value.

74. The system of claim 66, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

75. The system of claim 66, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

76. The system of claim 66, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

77. The system of claim 66, wherein the ultrasonic transducer is a pin probe.

78. The system of claim 66, further comprising an X-ray locating device.

79. The system of claim 65, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, a relaxation time (T_R) of the correlation coefficient (K) is not less than a predetermined second threshold value.

80. The system of claim 79, wherein the evaluating unit is further configured to average the relaxation time (T_R) of the correlation coefficient (K) over a plurality of shockwaves.

81. The system of claim 79, wherein the evaluating unit is further configured to standardize the relaxation time (T_R) of the correlation coefficient (K) to a reference relaxation time of a reference correlation coefficient curve.

82. The system of claim 79, further comprising means for the continuous representation of the relaxation time (T_R) of the correlation coefficient (K) over a treatment duration.

83. The system of claim 79, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

84. The system of claim 83, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

85. The system of claim 79, wherein the evaluating unit is configured to determine the relaxation time (T_R) by adapting a fit curve or a curve of the form $1 - A^{(-t/T_R)}$ to the variation of the correlation coefficient (K) with time.

86. The system of claim 85, wherein the evaluating unit is further configured to smooth the variation of the correlation coefficient (K).

87. The system of claim 79, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

88. The system of claim 79, wherein the evaluating unit comprises adjusting means for adjusting the second threshold value.

89. The system of claim 79, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

90. The system of claim 79, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

91. The system of claim 79, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

92. The system of claim 79, wherein the ultrasonic transducer is a pin probe.

93. The system of claim 79, further comprising an X-ray locating device.

94. The system of claim 75, further comprising a display device in communication with the evaluating unit and configured to display the variation of the correlation coefficient (K) with time.

95. The system of claim 94, wherein the evaluating unit is further configured to smooth the variation of the correlation coefficient (K).

96. The system of claim 94, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, the minimum value of the correlation coefficient (K) is not less than a predetermined first threshold value.

97. The system of claim 96, wherein the evaluating unit is further configured to average the minimum value of the correlation coefficient (K) over a plurality of shockwaves.

98. The system of claim 96, wherein the evaluating unit is further configured to standardize the minimum value of the correlation coefficient (K) to a reference minimum value of a reference correlation coefficient curve.

99. The system of claim 96, further comprising means for the continuous representation of the minimum value of the correlation coefficient (K) over a treatment duration.

100. The system of claim 96, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

101. The system of claim 100, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

102. The system of claim 96, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

103. The system of claim 96, wherein the evaluating unit comprises adjusting means for adjusting the first threshold value.

104. The system of claim 96, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

105. The system of claim 96, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

106. The system of claim 96, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

107. The system of claim 96, wherein the ultrasonic transducer is a pin probe.

108. The system of claim 96, further comprising an X-ray locating device.

109. The system of claim 94, wherein the evaluating unit is configured to provide an error signal if, after emission of a shockwave, a relaxation time (T_R) of the correlation coefficient (K) is not less than a predetermined second threshold value.

110. The system of claim 109, wherein the evaluating unit is further configured to average the relaxation time (T_R) of the correlation coefficient (K) over a plurality of shockwaves.

111. The system of claim 109, wherein the evaluating unit is further configured to standardize the relaxation time (T_R) of the correlation coefficient (K) to a reference relaxation time of a reference correlation coefficient curve.

112. The system of claim 109, further comprising means for the continuous representation of the relaxation time (T_R) of the correlation coefficient (K) over a treatment duration.

113. The system of claim 109, further comprising an alarm device in communication with the evaluating unit and supplied with the error signal.

114. The system of claim 113, wherein the alarm device is configured to output an optical alarm or acoustic alarm.

115. The system of claim 109, wherein the evaluating unit is configured to determine the relaxation time (T_R) by adapting a fit curve or a curve of the form $1 - A^{(-t/T_R)}$ to the variation of the correlation coefficient (K) with time.

116. The system of claim 109, wherein the evaluating unit is further configured to smooth the variation of the correlation coefficient (K).

117. The system of claim 109, wherein the shockwave generator is in communication with the evaluating unit and configured to stop or continue the generation of shockwaves dependent on the error signal.

118. The system of claim 109, wherein the evaluating unit comprises adjusting means for adjusting the second threshold value.

119. The system of claim 109, wherein the evaluating unit is configured to determine a temporal cross correlation function between the ultrasonic waves and to define the maximum value of the temporal cross correlation function as the correlation coefficient (K).

120. The system of claim 109, wherein the ultrasonic transducer of the ultrasonic transmitting/receiving unit is mounted on an adjustable holder.

121. The system of claim 109, wherein the ultrasonic transmitting/receiving unit is a part of an imaging ultrasonic scanner.

122. The system of claim 109, wherein the ultrasonic transducer is a pin probe.

123. The system of claim 109, further comprising an X-ray locating device.

124. A method for a lithotripter, comprising:

providing a shockwave generator;

providing an ultrasonic transmitting/receiving unit comprising an ultrasonic transducer;

providing an evaluating unit, in communication with the ultrasonic transmitting/receiving unit and the shockwave generator;

emitting ultrasonic pulses from the ultrasonic transducer into a body;

receiving the ultrasonic waves reflected from a target object in the body via the transducer;

evaluating the received ultrasonic waves with evaluating unit to determine a correlation coefficient (K) of a time correlation between the ultrasonic waves and the ultrasonic pulses; and

providing a signal related to the correlation coefficient (K) from the evaluating unit.

125. The method of claim 124, wherein evaluating the received ultrasonic waves comprises determining the correlation coefficient (K) based on the ultrasonic waves assigned to the ultrasonic pulses directly succeeding one another.

126. The method of claim 124, wherein evaluating the received ultrasonic waves comprises determining a temporal cross correlation function between the ultrasonic waves and defining the maximum value of the temporal cross correlation function as the correlation coefficient (K).

127. The method of claim 124, further comprising continuously representing the minimum value of the correlation coefficient (K) during a shockwave treatment of the body.

128. The method of claim 124, further comprising continuously representing the relaxation time(T_R) of the correlation coefficient (K) during a shockwave treatment of the body.

129. The method of claim 124, further comprising:

providing a display device in communication with the evaluating unit;

positioning the body within a focus of the shockwave generator;

displaying the target object and the focus on the display device;

adjusting the position of the body to place the target object within the focus of the shockwave generator;

determining the minimum value of the correlation coefficient (K) after the emission of a shockwave from the shockwave generator; and

storing the minimum value as a reference minimum value.

130. The method of claim 129, further comprising standardizing the minimum value of a second correlation coefficient (K'), measured at a later time, to the reference minimum value.

131. The method of claim 129, further comprising continuously representing the minimum value of the correlation coefficient (K) during a shockwave treatment of the body.

132. The method of claim 124, further comprising:

providing a display device in communication with the evaluating unit;

positioning the body within a focus of the shockwave generator;

displaying the target object and the focus on the display device;

adjusting the position of the body to place the target object within the focus of the shockwave generator;

determining the relaxation time (T_R) of the correlation coefficient (K) after the emission of a shockwave from the shockwave generator; and

storing the relaxation time (T_R) as reference relaxation time.

133. The method of claim 132, further comprising standardizing the relaxation time (T_R) of a second correlation coefficient (K'), measured at a later time, to the reference relaxation time.

134. The method of claim 132, further comprising continuously representing the relaxation time(T_R) of the correlation coefficient (K) during a shockwave treatment of the body.

135. The method of claim 124, further comprising providing an error signal from the evaluating unit to the shockwave generator if, after emission of a shockwave, the minimum value of the correlation coefficient (K) is not less than a predetermined first threshold value.

136. The method of claim 135, further comprising averaging the minimum value of the correlation coefficient (K) over a plurality of shockwaves.

137. The method of claim 135, further comprising standardizing the minimum value of the correlation coefficient (K) to a reference minimum value of a reference correlation coefficient curve.

138. The method of claim 124, further comprising providing an error signal from the evaluating unit to the shockwave generator if, after emission of a shockwave, the relaxation time (T_R) of the correlation coefficient (K) is not less than a predetermined second threshold value.

139. The method of claim 138, further comprising averaging the relaxation time (T_R) of the correlation coefficient (K) over a plurality of shockwaves.

140. The method of claim 138, further comprising standardizing the relaxation time (T_R) of the correlation coefficient (K) to a reference relaxation time of a reference correlation coefficient curve.